

GENERAL ELECTRIC

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We, at General Electric, welcome the opportunity to participate in the Point Focus Program managed by JPL and are pleased to be able to express some of our views at this panel discussion.

I brought a few vu-graphs to assist me in making the presentation and to focus our attention during the next few minutes (see Figure 1).

We believe that the Point Focus Dish engineering concept for renewable energy collection and, in particular, the generation of electricity--a premium form of energy--is a viable one. We are pursuing the concept, in conjunction with the JPL-defined component and system development programs.

Figure 2 shows several things. First, it shows the generation-by-generation development of point focus dishes, proceeding from the initial 7-meter dish at Shenandoah through the second generation Low Cost Concentrator of 12 meters, following on to an Advanced Concentrator yet to be defined. Under each of these particular concentrators, I have illustrated the finite cycle of development that has occurred, or is planned to occur. Specifically, the Shenandoah design cycle has been completed, as has been its fabrication and test cycle. It is presently under implementation in the construction of the total energy system at Shenandoah, Georgia.

Feeding from the experience gained from the Shenandoah collector development, after the first fabrication and test experience, the second generation Low Cost Concentrator was conceived and proceeded into design. Fabrication has been initiated and testing is planned for later this year and, in fact, several system applications using various engines--Rankine, Brayton, and Stirling--have been identified and planned.

Following the experience gained after the testing of the Low Cost Concentrator, a third generation advanced concentrator is planned to enter into a complete cycle from design, then fabrication and test, and then into application.

This arrangement of generation-by-generation development of the critical component designs, so that lessons learned from one generation can be incorporated into the design of the following generation, is a very sound one and indicates that the planned program by JPL and DOE is a sound, orderly, and well-managed development activity.

Supporting the generation-by-generation product evolution, at the bottom of the chart, I have shown the supporting technology required to hasten the component developments, these being high temperature material, research and development, reflective surface developments, construction and use of the test bed concentrators for general knowledge gained, as well as development of advanced receiver and high temperature engines.

There are two keys to the successful completion of a conceptual development, which this chart hopefully illustrates. First, an orderly generation-by-generation development cycle to produce an ultimate product and, secondly, the continuity in the program to carry through in a continuous fashion the design teams and contractors involved in the programs.

I will attempt now to run quickly through the critical technology needs as we are facing them in the development of point focus concentrators (see Figure 3). One of the key technology needs is the development of cost-effective, long-life reflectors.

Quite a bit of technical work still must be done in order to achieve performance and cost goals to evolve a commercially viable product. Both the silvered-glass mirrors and metallized films which are being pursued today have their shortcomings. The concept outlined under "Approach" on the chart should be supported by separate technical efforts to provide a basis to produce effective commercial products.

Figure 4 illustrates one concept of the integrated reflective surface and structure that General Electric has been working on. We recognize that it is just a first step along the path that I have previously indicated.

In an attempt to evolve low cost concentrators, we have identified the need to employ new and low cost structural materials to be cost-effective. Structural plastics have the potential of satisfying these needs. In the construction of the Low Cost Concentrator, we are employing structural plastics to demonstrate the application and cost reduction potential, and Chart 5 does indicate additional needs.

In Figure 6 we are illustrating some of the work in molded plastics that we, at General Electric, have developed for the application to solar use, as well as other large structural members, such as appliances and automobile parts. The evolution of single component molding compounds allows the use of relatively low cost molds with high production rates within those molds.

Figure 7 is a picture of an engineering prototype mold of approximately the same curvature and size as one of the elements to be molded for the Low Cost Concentrator 12-meter dish. It is a proof-of-concept mold and has worked out quite well.

Figure 8 shows a finished molded part which has been produced in the mold shown previously. Its surface contour and structural properties are as designed.

To show further application of molded structural plastics, we have designed and fabricated a low cost molded trough whose parts are shown here. The type of structural detail and reinforcement which can be achieved are excellent and the strength and surface tolerances required can be achieved using molded structural plastics (see Figure 9).

General Electric has also been involved in engine receiver development activities for DOE and JPL (Figure 10). Specifically we have evolved a multi-vane rotary expander Rankine cycling engine and have developed Stirling engine designs and hardware.

We have developed a family of receivers, from the initial cavity receiver used for the original Shenandoah 7-meter dish, applicable to Rankine cycling engines, to a high temperature receiver applicable to Brayton cycling engines, and culminating in the heat pipe receiver that is being developed presently for Stirling engines. This receiver does have energy storage capacity within it.

Figure 11 gives a view looking through an appropriate filter into the receiver aperture of the GE-developed 7-meter dish system on test at Sandia Laboratories, Albuquerque facility. Output fluid from the receiver tubes is at 750°F. You can see the concentrated solar energy distribution on the coils within the receiver produced by the 7-meter concentrator.

Because point focus dishes, of necessity, are 2-axis tracking, the need for controls and sensors is inherent. Also, the various modes of operation, including start-up and shutdown logic, routine and emergency focus and defocus, and other operations, are required. Figure 12 shows the general development needs within this area.

As I mentioned previously, one of the key elements to recognize in the development of a commercial product is the necessity for a number of required design cycles (see Figure 13). Each cycle proceeding from initial design through fabrication and field service must be completed before the next cycle can legitimately be started. Our experience in industry has been that at least three of these cycles, and sometimes more, are required before a commercial product evolves. The JPL program, as designed, does have built within it these design cycles. It is necessary that the program be retained with these features, and the continuity to maintain the flow of knowledge and development in industry be maintained.

Figure 14 shows one example of many I could have chosen to illustrate the product evolution design cycle phenomenon. The development of air-conditioning equipment for private homes, for example, went through this process with the result that over one half the homes built today in the United States are equipped with central air-conditioning, not to mention all of the commercial and institutional buildings which have air-conditioning incorporated within them. The road to this commercial product was one that went through three, and possibly four, design cycles as the product moved from the early prototype stage through that of an emerging product to the cost-effective reliable commercial product that industry supplies today.

Figure 15 shows what one quad of energy supplied to the United States would mean in terms of various types of energy generation. It compares the required 1 million parabolic dishes to the 17 equivalent nuclear plants and the vast amount of fossil energy required to replace this renewable energy source.

In summary, we at General Electric believe solar thermal parabolic dish energy applications:

- (1) Are a viable distributed renewable power generating option.
- (2) Produce quality energy in the form of electricity and high temperature heat.

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- (3) Are modular and can be distributed to new or existing plants in increments.
- (4) Are factory mass producible with associated economies of production.
- (5) Have progressed under DOE and industry development.
- (6) Can be developed to produce renewable energy in support of the nation's energy goals.

Thank you.



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SOLAR THERMAL PARABOLIC DISH ENERGY APPLICATIONS

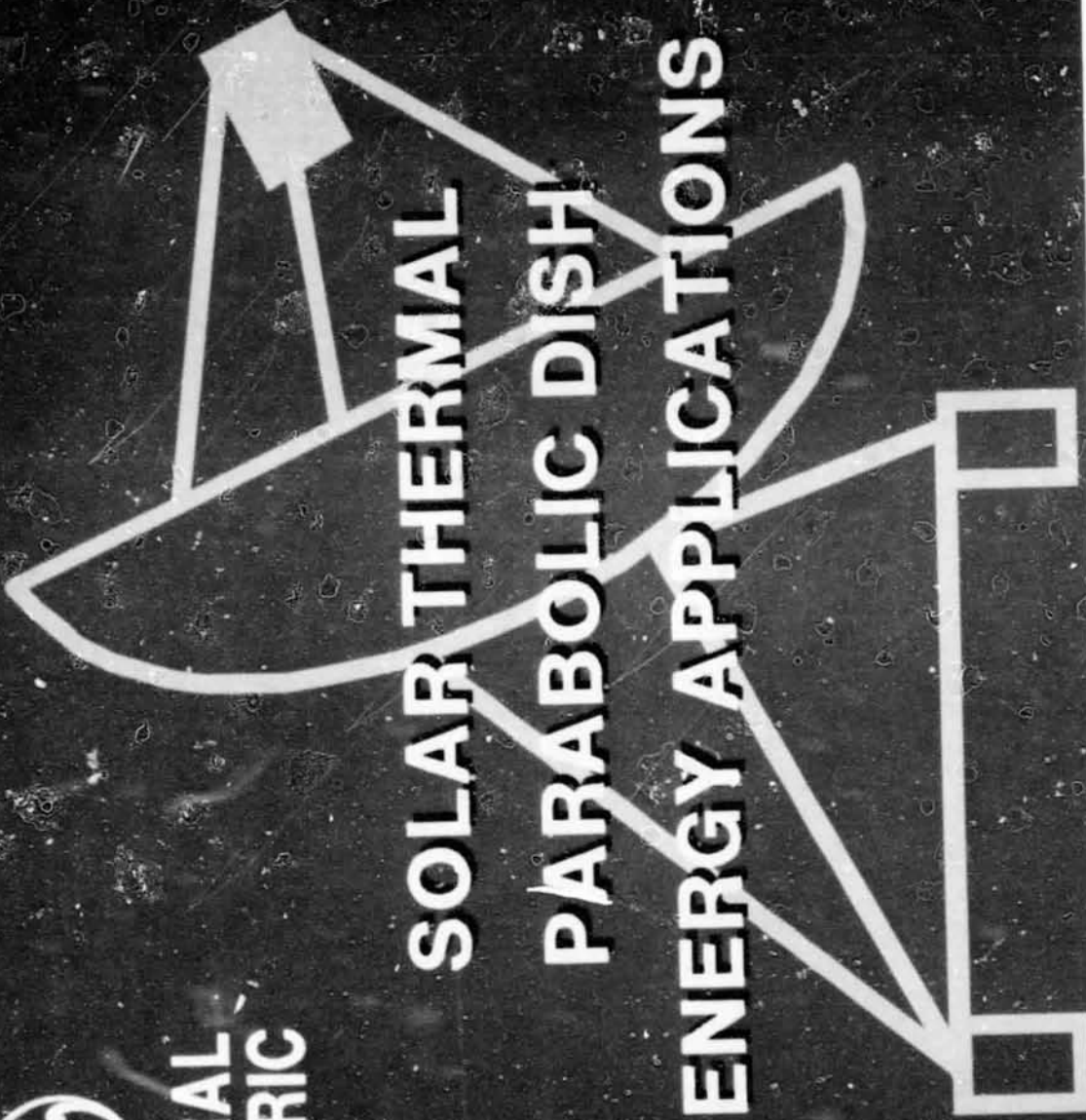


Figure 1.



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DISH TECHNOLOGY DEVELOPMENT AND DEMONSTRATION

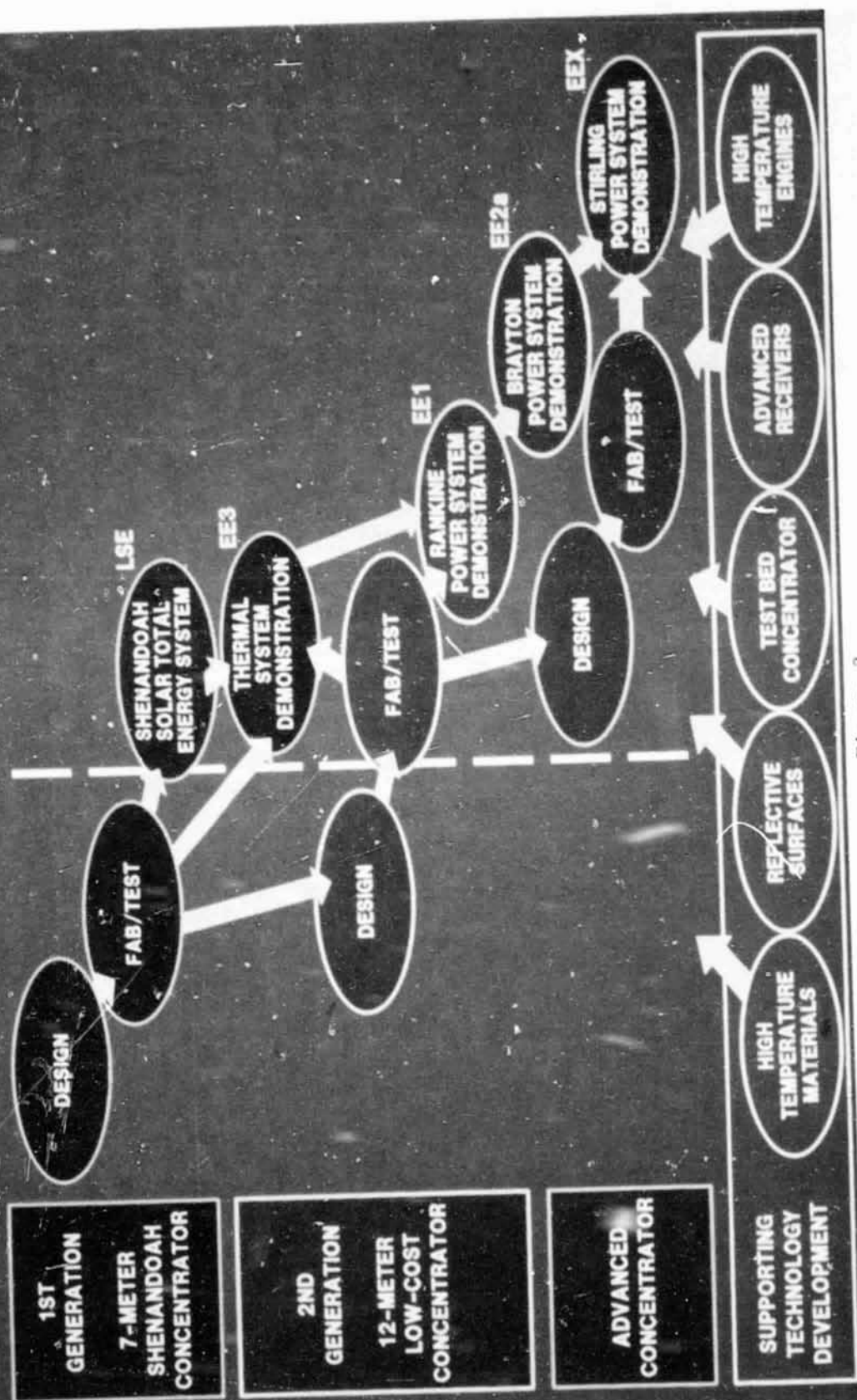
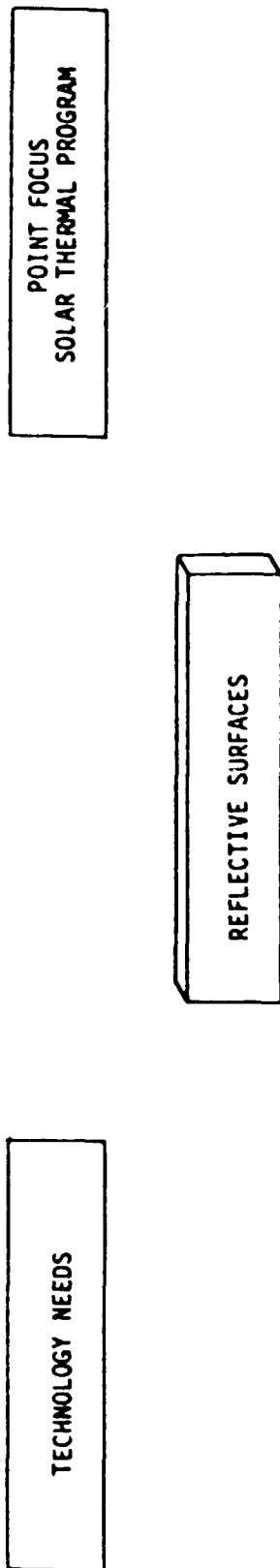


Figure 2.

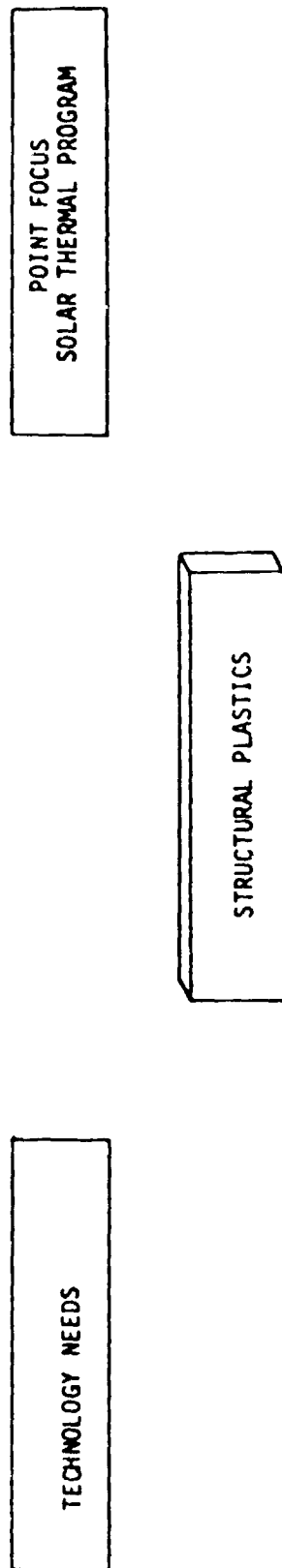


- COST EFFECTIVE, LONG LIFE REFLECTOR REQUIRED
- APPROACH
 - DEVELOP LOW COST SILVER INTEGRATED REFLECTORS
 - IMPROVE DURABILITY OF METALIZED FILMS
 - UTILIZE GLASS COATED ALUMINUM AND SILVER REFLECTORS

Figure 3.



Figure 4.



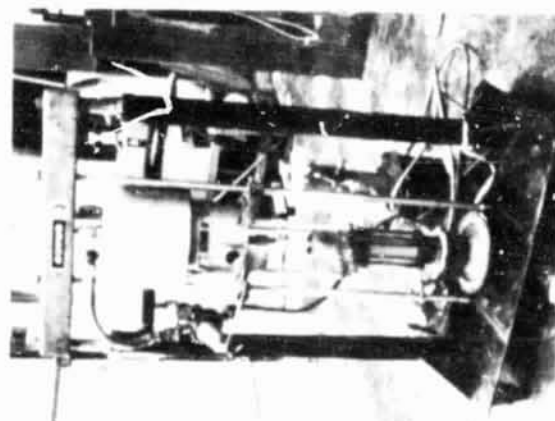
- EVOLUTION OF MATERIAL, PROCESS AND COMPONENT DESIGN
- GENERATION OF PROPERTY AND PERFORMANCE DATA
- REFLECTOR - SUBSTRATE INTEGRATION
- GENERATE COST DATA BASE FOR PRODUCTION

Figure 5.

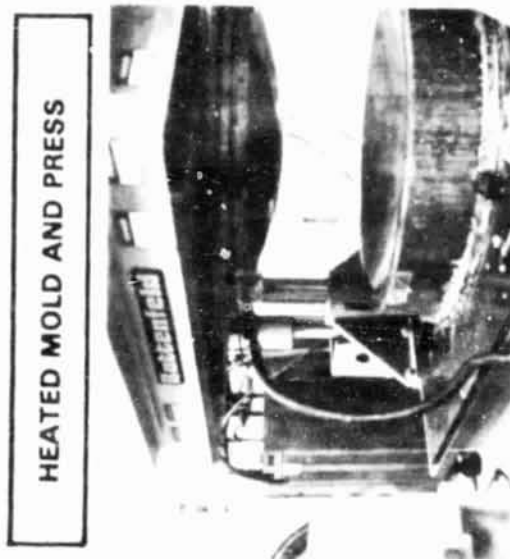


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CANDIDATE LARGE STRUCTURAL PART PROCESS EQUIPMENT

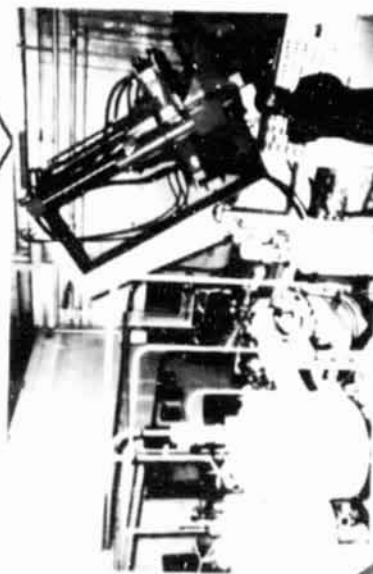


SINGLE COMPONENT EQUIPMENT



HEATED MOLD AND PRESS

MOLDED 1 METER DISH



CONVENTIONAL TWO COMPONENT RIM
EQUIPMENT

Figure 6.



Figure 7.

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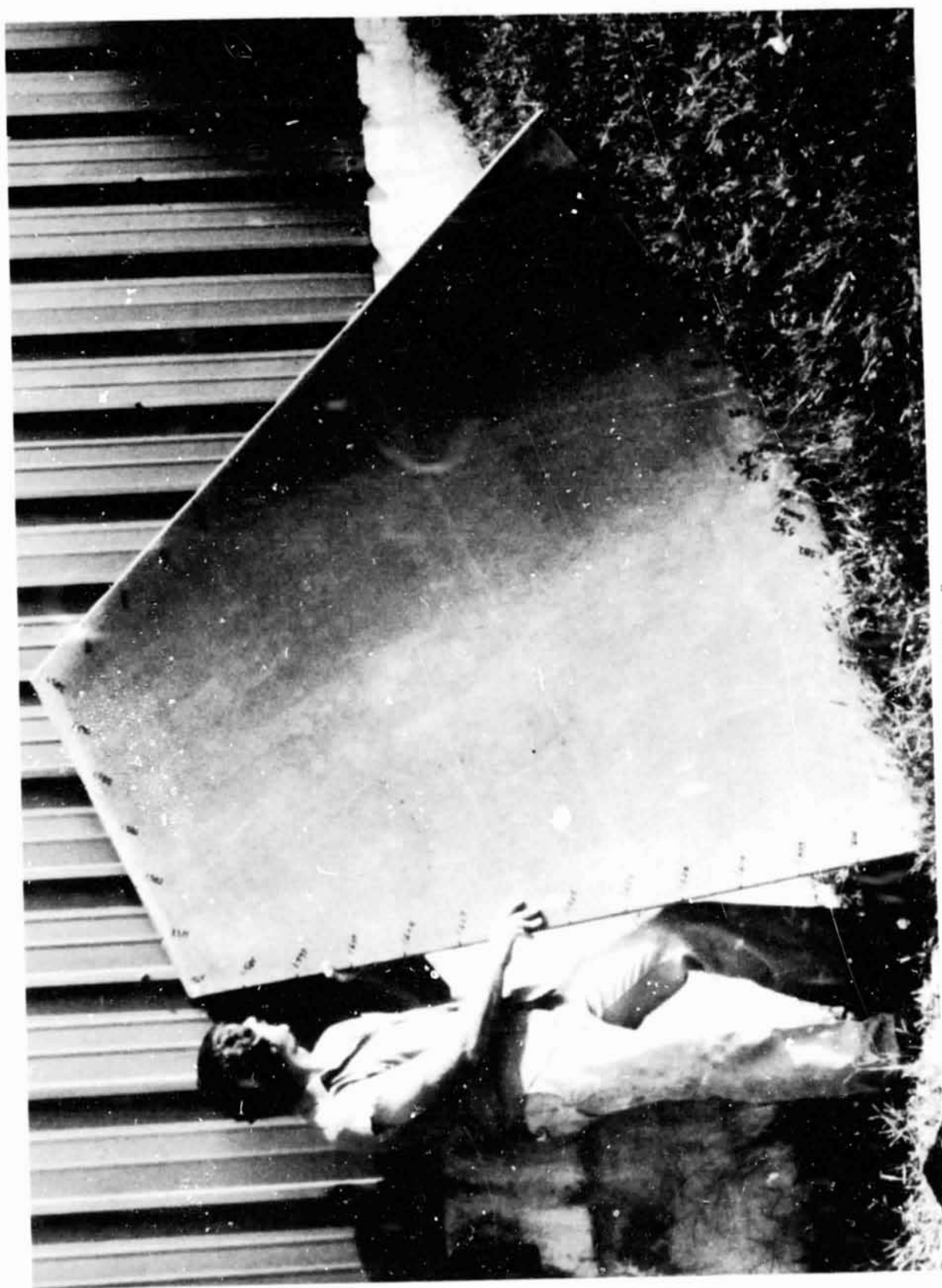


Figure 8.

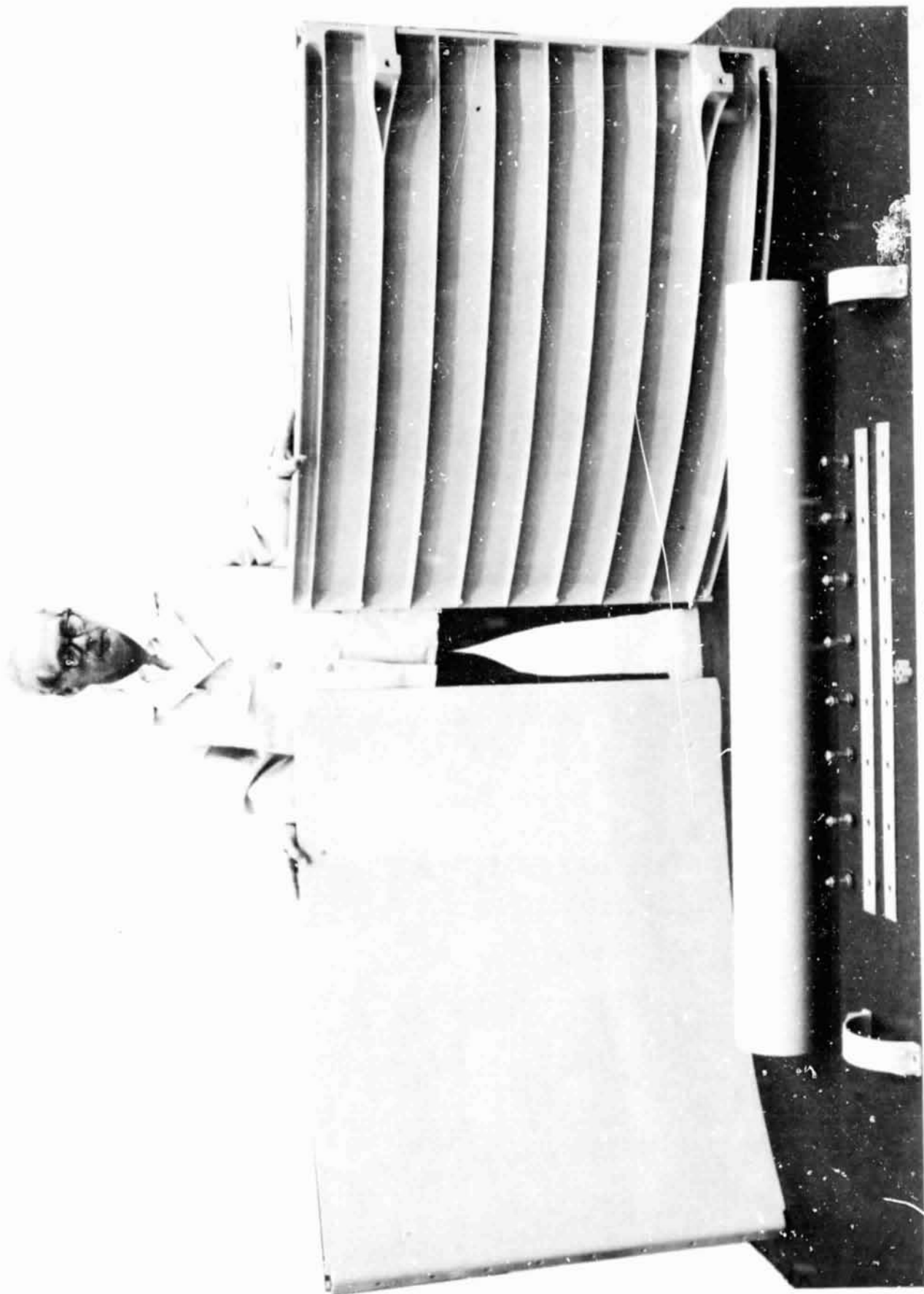


Figure 9.

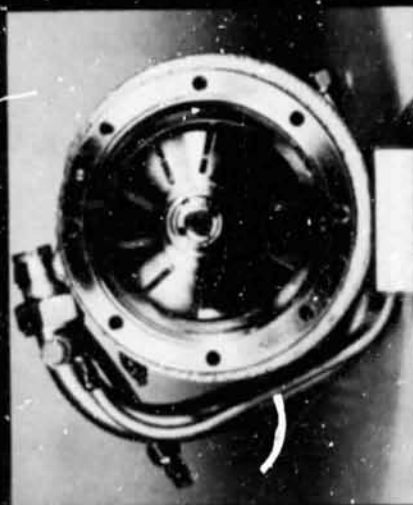


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Engine/Receiver Program Activity



RANKINE



MULTI-VANE ROTARY EXPANDER

RANKINE RECEIVER



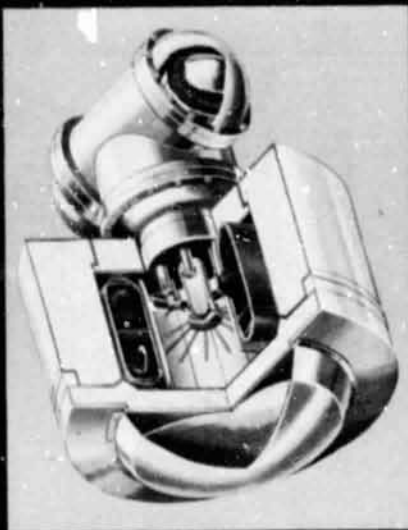
2ND GENERATION LSE RECEIVER

BRAYTON



HIGH TEMPERATURE RECEIVER

STIRLING



STIRLING ENGINE DEVELOPMENT

STIRLING ENGINE RECEIVER



HEAT PIPE RECEIVER

Figure 10.

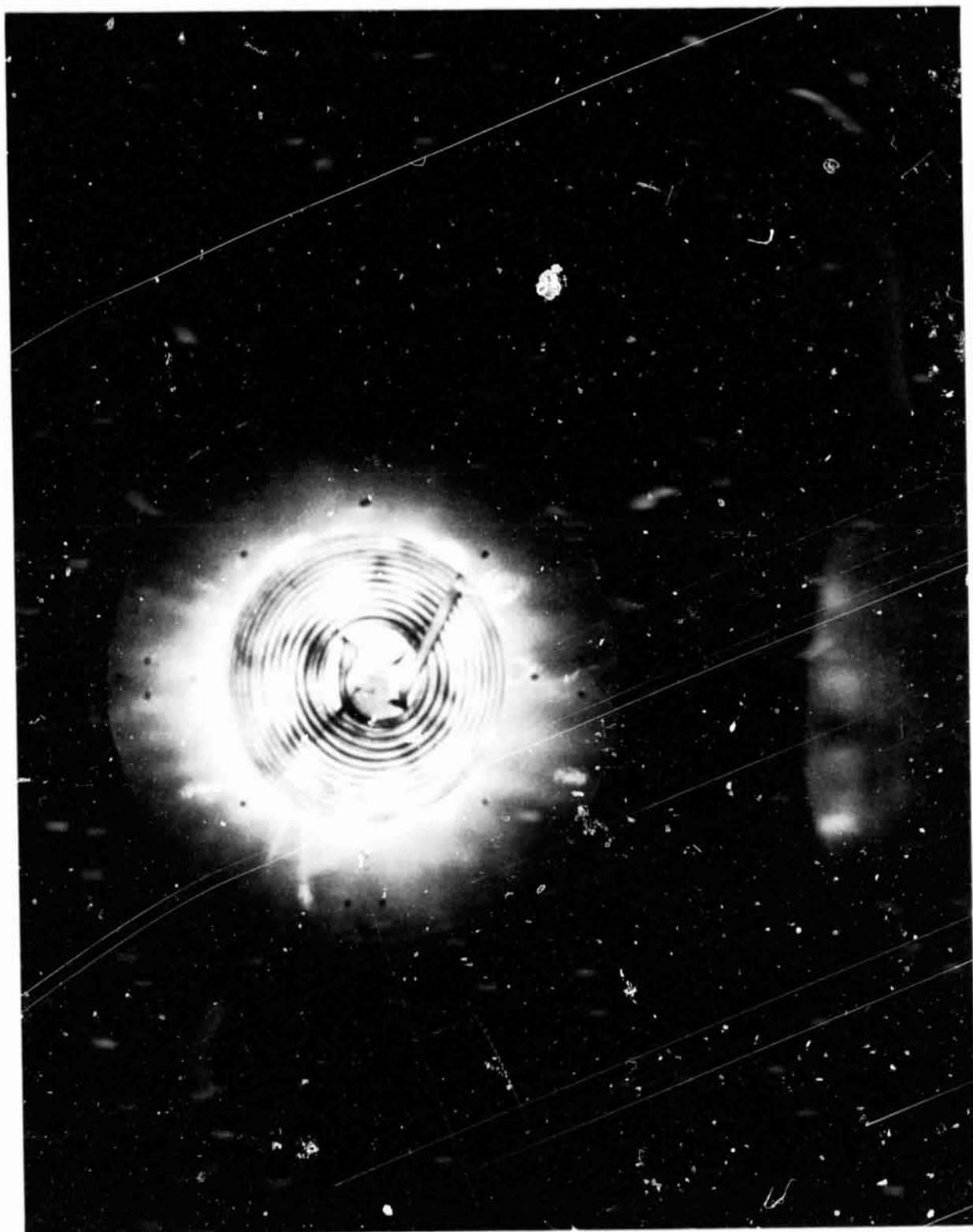


Figure 11.

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POINT FOCUS
SOLAR THERMAL PROGRAM

CONTROLS AND SENSORS

TECHNOLOGY NEEDS

- GENERAL CONTROL PROCESS
- INPUT
- SUN SENSOR
 - COURSE POSITION CALCULATION
 - EPHEMERIS DATA
 - OPERATOR INTERFACE AND OUTPUT
- PROCESS
- READ SUN SENSOR SIGNAL
 - COMPARE TO CALCULATED POSITION
 - SELECT SUN SENSOR OR COURSE CONTROL
 - GENERATE DRIVE COMMAND
 - DATA TRANSFER
- OUTPUT
- POSITION DRIVE COMMAND
- ADDITIONAL DEVELOPMENT
- HARDWARE/SOFTWARE TRADEOFFS
 - HARDWARE DEVELOPMENT
 - REQUIREMENTS DEFINITIONS
 - DETAILED
 - TAILORED TO SPECIAL APPLICATIONS
 - UNNECESSARY REQUIREMENTS ELIMINATED
 - SUN SENSOR SENSITIVITY TO GLINT AND CLOUD COVER

Figure 12.

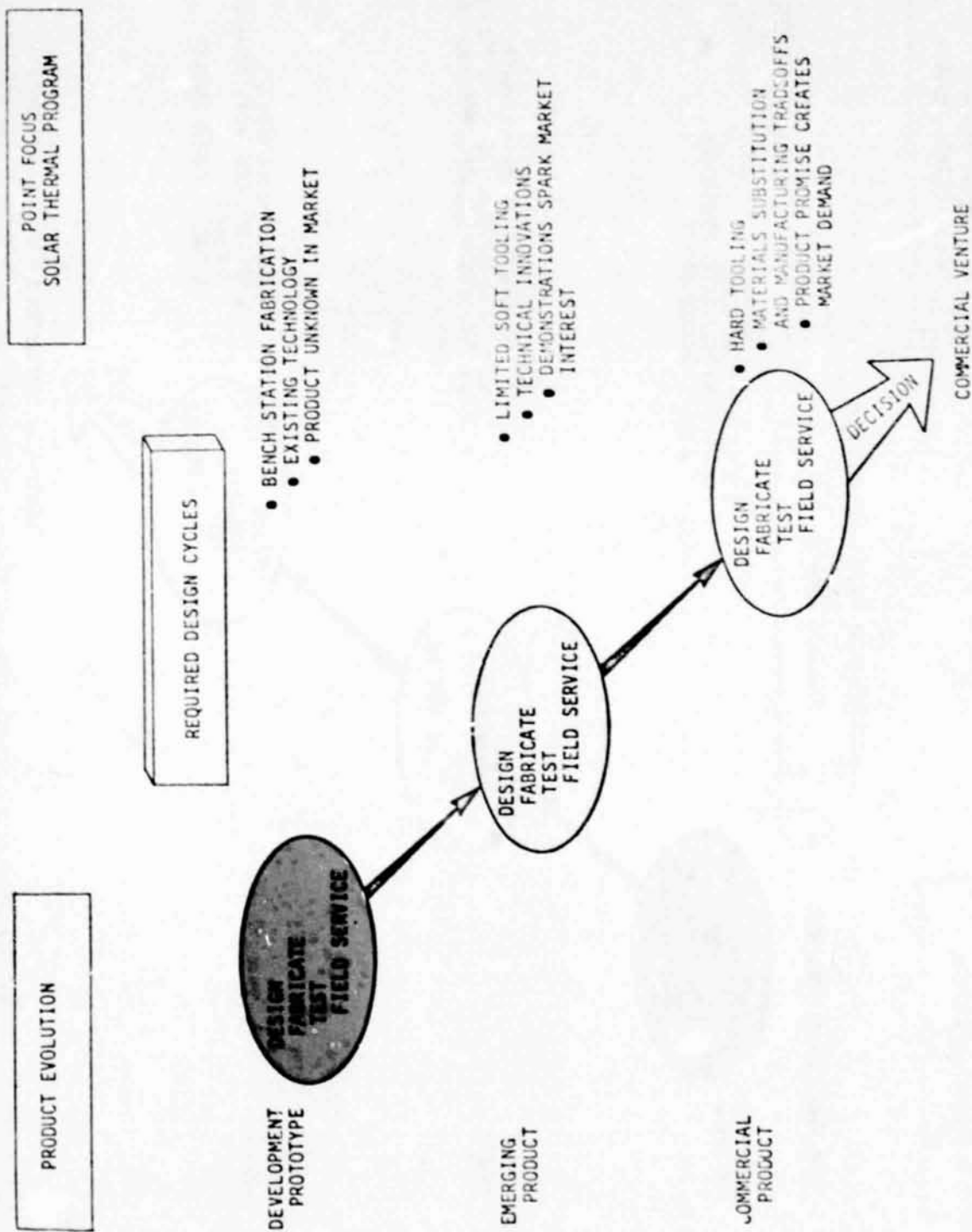


Figure 13.

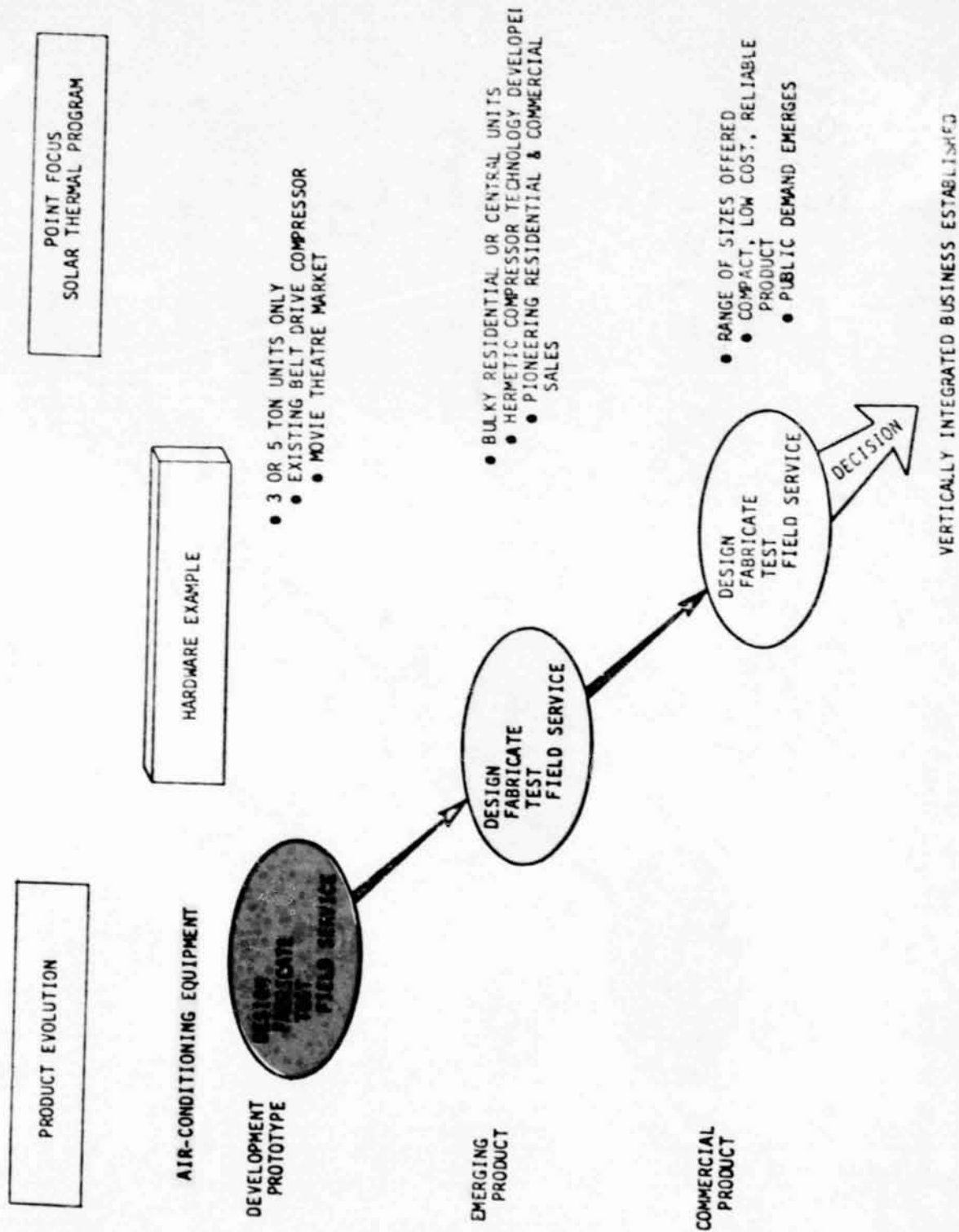


Figure 14.



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POTENTIAL DISH CONTRIBUTION

BY THE YEAR 2000, PARABOLIC DISH SYSTEMS HAVE THE POTENTIAL TO SUPPLY 1 QUAD/YEAR TOWARD MEETING THE U.S. ENERGY REQUIREMENT AND CAN PLAY AN INTEGRAL ROLE IN ACHIEVING THE NATIONAL ENERGY GOAL OF 3 QUADS/YEAR OF SOLAR THERMAL GENERATED POWER

1 QUAD/YEAR = 1 MILLION PARABOLIC DISHES

= 17 NUCLEAR PLANTS

= 50 MILLION TONS COAL/YR.

= 200 MILLION BARRELS OF OIL/YR.

= SAN FRANCISCO METROPOLITAN
AREA POWER REQUIREMENT

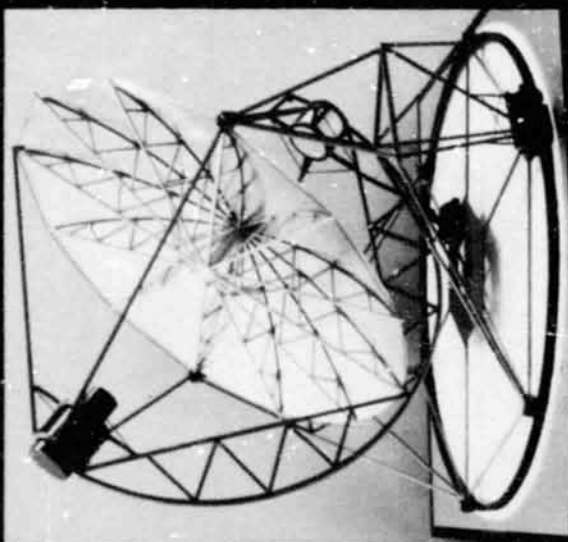


Figure 15.



SUMMARY

SOLAR PARABOLIC DISH SYSTEMS:

- ARE A VIABLE DISTRIBUTED RENEWABLE POWER GENERATING OPTION
- PRODUCE QUALITY ENERGY IN THE FORM OF ELECTRICITY AND HIGH TEMPERATURE HEAT
- ARE MODULAR AND CAN BE DISTRIBUTED TO NEW OR EXISTING PLANTS IN INCREMENTS
- ARE FACTORY MASS PRODUCIBLE WITH ASSOCIATED ECONOMIES OF PRODUCTION
- HAVE PROGRESSED UNDER DOE AND INDUSTRY DEVELOPMENT
- CAN BE DEVELOPED TO PRODUCE RENEWABLE ENERGY IN SUPPORT OF THE NATION ENERGY GOALS

Figure 16.